Performance Standards of Comprehensive Airway Management for Emergency Medicine Residents

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ABSTRACT

Background: The Emergency Medicine (EM) Milestone Project provides guidance for assessment of resident trainee airway management proficiency (PC10). Although milestones provide a general structure for assessment, they do not define performance standards. The objective of this project was to establish comprehensive airway management performance standards for EM trainees at both novice and mastery levels of proficiency.

Methods: Comprehensive airway management standards were derived using standard-setting procedures. A panel of residency education and airway management experts was convened to determine how trainees would be expected to perform on 51 individual tasks in a standardized airway management simulation encompassing preparation, endotracheal intubation, backup airway use, and ventilation. Experts participated in facilitated exercises in which they were asked to 1) define which items were critical for patient safety, 2) predict the performance of a "novice" learner, and 3) predict the performance of a "mastery" learner nearing independent practice. Experts were given a worksheet to complete and descriptive statistics were calculated using STATA 14.

Results: Experts identified 39 of 51 (76%) airway management items as critical for patient safety. Experts also noted that novice trainees do not need to complete all the items deemed to be critical prior to starting practice since they will be supervised by a board-certified EM physician. In contrast, mastery-level trainees would be expected to successfully complete not only the critical tasks, but also nearly all the items in the assessment (49/51, 96%) since they are nearing independent practice.

Conclusion: In this study, we established EM resident performance standards for comprehensive airway management during a simulation scenario. Future work will focus on validating these performance standards in current resident trainees as they move from simulation to actual patient care.

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Patients undergoing airway management and endotracheal intubation (ETI) during emergency circumstances are at increased risk for adverse events (25%–30%)[1] compared to patients treated in elective circumstances (0.2%).[2] While acuity differences and limited time for preparation explain part of this safety gap, public and professional expectations are that practitioners should be able to demonstrate mastery performance.[3] In a variety of academic health centers, documentation of suboptimal airway management performance has been reported in intensive care settings and emergency departments (EDs).[4–8] First-pass success rates for emergency medicine (EM) trainees have been measured at 83% overall with postgraduate year (PGY)-1 residents at 72%, PGY-2 residents at 82%, PGY-3 residents at 88%, and PGY-4 residents at 82%.[4] For physician trainees preparing for practice settings where airway management is required, but infrequently performed, the methods for mastering and maintaining safe and effective levels of performance remain undefined.

The Milestone Project provides guidance for assessment of EM resident procedural competencies (ACGME 2015). The airway management subcompetency (PC10) provides a roadmap of increasing patient complexity and procedural competencies through which a resident navigates in stepwise progression across milestone levels until they transition to instructor level at milestone level 5. To demonstrate competency and progress out of level 4, residents are required to have completed a minimum of 35 intubations. This number corresponds to the minimal number of intubations required for completion of training as described in the EM Program Requirements. Although this paradigm provides general guidance for resident training, it does not define mastery performance of airway management skills.

Clearly defining airway management mastery performance standards and training learners to achieve mastery level performance, along with periodic reassessment and remediation, may result in decreased rates of complications and adverse events. In this study, we established performance standards for comprehensive airway management by defining expectations for overall patient safety and then defining both novice and mastery levels of proficiency for EM trainees. This was done using a standard-setting procedure completed by experts in residency education, airway management, and simulation. By identifying these standards, we hope to better assess the proficiency level of trainees and determine the need for further skills development.

METHODS

Rationale for Item-based Standard Setting

Standard setting for comprehensive airway management is essential for identifying learners who have attained a mastery level of skill performance. The goal of this type of standard setting is to articulate levels of performance such that all learners know what is required of them to be well prepared for future practice.[9] The use of mastery testing combined with a competency-based curriculum for residency programs has been shown to significantly improve patient outcomes.[10–12] Specifically, standard setting allows educators to identify trainees who have achieved mastery in residency and those who may need further assistance in skill development.

This was an item-based standard-setting procedure, utilizing a defined airway management situation, in which experts were asked to: 1) define which airway management tasks (items) are needed to be performed properly because they were critical to patient safety or outcome, 2) define the performance of a well-prepared "novice" learner, and 3) define the performance of a "mastery" learner.[13] In our setting, the novice learner is a new PGY-1 resident who is beginning an EM residency and is well prepared for the next level of training, which can include supervised practice with real patients. In comparison, a mastery learner is an individual who is near the graduation target for residency and is well prepared to demonstrate the translation of their simulation mastery to the independent care of real patients.

Standard-setting Methodology

To develop standards of performance for comprehensive airway management, the modified Angoff and patient-safety standard-setting procedures were employed.[9,14,15] Both methods were compared to identify which is most appropriate for EM residents at different levels of training who are overseen by board-certified physicians who assure patient safety.

A panel of experts was convened to make judgments about how trainees would be expected to perform on individual items or behaviors during a simulated airway management performance assessment. The panel consisted of 11 experts in EM graduate medical education, airway management and

simulation recruited from the Airway Mastery Collaborative (AMC). The Airway Mastery Collaborative is an interdisciplinary, multi-institutional group of EM, anesthesiology, educational methodology, psychometric, and biostatistics investigators who research airway management education and safety.

The expert panel members were able to join the standard-setting meeting in person or via electronic communication. Upon arrival to the standard-setting meeting, the expert panel were oriented to the standard-setting exercise and the specific comprehensive airway management performance assessment (see below). Experts then participated in a 1-hour facilitated discussion about the airway management tasks they would expect a well-prepared novice trainee and a mastery level EM trainee to be able to effectively perform. This standard-setting discussion occurred using the framework of a simulated comprehensive airway scenario that would typically be used to assess trainees. During the discussion, the experts identified specific characteristics of these learner groups including challenges they face on the path to developing mastery of the individual tasks and aggregate skills.

Following this discussion, a calibration exercise was conducted. Experts were asked to complete a five-item practice standard-setting worksheet (Figure 1). During the calibration, experts were asked to consider each comprehensive airway management task (e.g., positions patient optimally) and indicate: 1) whether performing the task correctly was critical to patient safety and/or outcome (yes/no); 2) whether a beginning resident would be expected to properly perform this task (yes/no); 3) the probability that a well-prepared, beginning resident would be able perform the task (0%–100%); 4) whether a mastery level resident would be able to properly perform this task (yes/no); and 5) the probability that a mastery level resident would be able to perform this task (0%–100%). Results of the worksheet were electronically tabulated and projected for the group of experts to review. For each task on the worksheet, the results were discussed and experts were asked to state their opinion and reasons behind their judgment. These five items and the discussion around them were used to develop clear concepts of novice and mastery performance.

At the conclusion of the meeting the experts were charged with completing the five judgments for each of the 51 tasks on the full standard-setting worksheet (Data Supplement S1, Appendix 1, available as supporting information in the online version of this paper, which is available at http://onlinelibrary.wiley.com/doi/10.1002/aet2.10127/full). The full worksheet was distributed electronically, and experts were given 24 hours to complete the exercise. Following completion, the data were tabulated and analyzed.

Comprehensive Airway Scenario Description

The comprehensive airway management performance assessment used for this standard-setting exercise

	Critical to patient safety and/or outcome? (yes/no)	Beginning resident must do item to pass? (yes/no)	Probability that a well prepared, beginning resident will accomplish this task (0-100%)	Mastery level resident must do item to pass? (yes/no)	Probability that a mastery level resident will accomplish this task (0-100%)
Positions patient optimally (trauma, ramp, sniffing)					
Does not assess gag reflex					
Assures continuous pulse oximeter					
Identifies primary and back-up plan					
States correct dose induction agent (local standards)					

Figure 1. Practice standard-setting worksheet.

describes a complex airway management situation that assesses four skill sets: 1) preparation for the procedure, 2) endotracheal tube placement, 3) backup airway placement, and 4) ventilation. The simulation is framed as a challenging airway case, involving a trauma scenario and a patient with the potential for a severe head injury. The simulation uses a realistic high-fidelity manikin with a rigid cervical collar already applied and an artificially inflated tongue. The scenario is started with the following script:

> You are an emergency physician managing a patient following a motor vehicle collision. Your patient is a 70-year-old male. He is 5'10" and about 90 kg. Inside the ED, you find him making incomprehensible sounds. With painful stimuli, he opens his eyes and withdraws. He has a boggy contusion in the left temple area. You are the only emergency physician available. Proceed as you normally would."

Trainees are then presented with the patient's vital signs: "Vital signs: BP 150/70, HR 110, RR 30, O2 saturation on NRB 95%."

Following this, trainees proceed through the airway simulation as outlined in Figure 2. The overall goal of the simulation is a comprehensive assessment of the approach to a difficult airway. So that all skill sets are appraised, trainees are required to continue the assessment even if they successfully intubate the patient within their first three attempts. This is done by allowing the trainee to follow one of two pathways through the simulation: 1) successfully intubating the patient or 2) failing to intubate the patient. If the trainee successfully intubates the patient, the following information is provided:

> The endotracheal tube was dislodged accidentally. You have attempted to intubate this patient twice since your first successful endotracheal intubation. You note that the airway is significantly edematous, full of secretions and you are unable to visualize the ET tube pass through the vocal cords. The ETCO2 is 0; Pulse oximetry is 70%. Please proceed with the scenario.

If the trainee fails to intubate during the scenario, the trainee is allowed to continue to manage the airway with the use of a backup airway device.

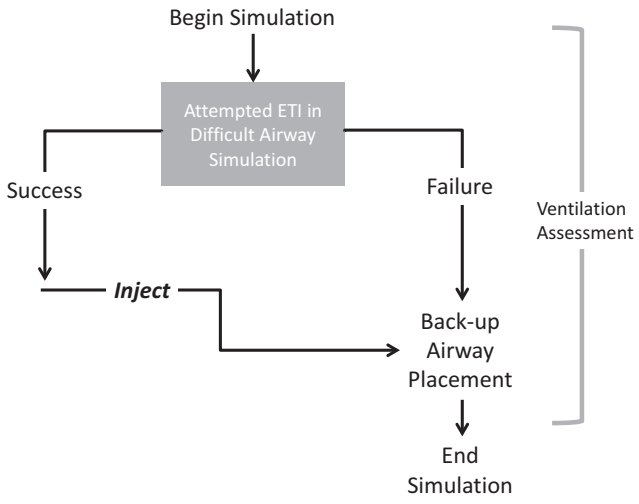

Figure 2. Flow diagram of comprehensive airway management scenario for standard-setting exercise. Trainees begin the scenario and are asked to perform an ETI. If they are successful, they receive an inject directing them to place a backup airway due to dislodgement. If they fail, they will progress to back up airway placement. Throughout the simulation, performance of ventilations is assessed. ETI = endotracheal intubation.

Ventilation performance is evaluated throughout the entire simulation.

The instrument that accompanied the scenario is composed of 51 items covering the four skills sets involved in comprehensive airway management: preparation (nine items), ETI (21 items), backup airway placement (12 items), and ventilation (nine items). The instrument was originally established through previous research involving assessment of comprehensive airway management in the prehospital setting[16,17] and has been adapted for the in-hospital setting by the Airway Mastery Collaborative using expert consensus on items needed for resident comprehensive airway management.

Analysis Plan

As part of the standard-setting process, analyses were conducted in three phases: 1) determine the airway items which are critical for overall patient safety irrespective of the learner, 2) determine proficiency standards for a well-prepared novice resident (new PGY - 1), and 3) determine proficiency standards for a mastery-level resident who is nearing independent practice. Study data were tabulated and descriptive statistics were conducted using STATA 14 (Stata Statistical Software, Release 14, 2015, StataCorp LP).

Standard Setting for Patient Safety. Experts were directed to determine which airway management

items are critical for patient safety or outcome (Data Supplement S1, Appendix 1). An airway task was considered to be critical for patient safety if 70% or more of the experts rated the task as critical.

Standard Setting for Novice Proficiency. The data from the expert judges concerning novice proficiency were collected. The novice proficiency standard setting asked what specific skills a well-prepared beginning trainee must be able to do prior to direct patient care. The collected data were used to implement two standard-setting procedures (modified Angoff and modified patient-safety analyses).[9] As noted, both methods were compared to identify which is most appropriate for EM residents at different levels of training that are overseen by board-certified physicians who assure patient safety.

The first method of standard setting was via the modified Angoff procedure where, for the novice competency level, the probabilities assigned to each task were averaged across the judges and then summed across tasks. This sum is the expected raw score of the well-prepared learner (at either the beginner or the mastery level) and then divided by total number of tasks generating a percentage cut score.

The second method is a modified patient-safety method where the judges are asked to indicate, for a novice trainee, whether the trainee must do the specific airway item to pass to assure patient safety (Data Supplement S1, Appendix 2).[9] To be more rigorous and patient safety focused, tasks were identified as important for patient safety if a simple majority of experts rated the task as one that must be accomplished by the novice resident to pass. The cut score for the modified patient-safety method is the completion of all items designated as those that must be completed at the novice competency. Performance of the noncritical items does not compensate for missing a critical item.

Standards for Mastery Proficiency. Finally, after evaluation of novice proficiency, the data from the expert judges concerning mastery skills competency were assessed. The mastery proficiency standard asked what specific skills a mastery proficiency trainee, who is nearing independent practice, must be able to do (Data Supplement S1, Appendix 1). The collected data were used to implement the two standard-setting procedures (modified Angoff and modified patient-safety analyses) as described above.

RESULTS

Airway management and graduate medical education experts were recruited and brought together for the standard-setting meeting on November 2016. Data Supplement S1, Appendix 2 describes each of the subject matter experts' affiliations and titles. A total of 11 experts were recruited and completed all steps of the standard-setting exercise.

Experts defined two performance levels of comprehensive airway management—novice and mastery-level performance—and set standards for both. The calibration procedure lasted 1.5 hours to provide sufficient time for discussion concerning proficiency levels, understanding of the simulation assessment, and practice with the standard-setting worksheet (Figure 1). Following the discussion, experts independently completed the electronic surveys for scoring the 51 airway management items.

Critical for Patient Safety and Outcome

Experts designated 39 of the 51 (76%) items as critical for patient safety or outcome (Table 1). These items were considered independent of the level of learner. In other words, they must be performed effectively regardless of the skill level of the rescuer.

Novice Airway Proficiency

The tabulated data on each performance item for novice proficiency are shown in Table 2. Using the modified Angoff procedure, experts determined that the novice resident would need to perform 38 of 51 (73%) of the items correctly to pass the assessment. However, when we evaluated the experts' consideration of the patient-safety approach,[9] they determined that a well-prepared beginning resident needed to correctly execute 25 of 51 items (49%) to pass. This finding suggests that experts focused on the need for beginning residents to be skilled enough to assure safe task performance. The tasks that experts identified as essential included the use of monitoring; understanding, selecting, and using appropriate equipment for airway management; identifying esophageal intubation through a variety of confirmation methods; and being able to appropriately ventilate patients through bag-valve-mask.

Mastery Airway Proficiency

Item results for mastery-level proficiency are also shown in Table 2. Using the Angoff procedure to

Table 1
Tasks From Comprehensive Airway Management Process Identified by Expert Panel as Critical for Patient Safety and Outcome

Item Number	Item Description	Frequency (%)	Critical for Patient Safety/Outcome
1	Positions patient optimally (trauma, ramp, sniffing)	11 (100)	Yes
2	Does not assess gag reflex	7 (63.6)	No
3	Assures continuous pulse oximeter	11 (100)	Yes
4	Identifies primary and backup plan	11 (100)	Yes
5	States correct dose induction agent (local standards)	10 (90.9)	Yes
6	States correct dose neuromuscular blockade (local standards)	11 (100)	Yes
7	Uses straight-to-cuff stylette curvature technique	4 (36.4)	No
8	Checks equipment for cuff leaks	10 (90.9)	Yes
9	Maintains C-spine precautions during airway management	11 (100)	Yes
10	Uses cricoid pressure	11 (100)	Yes
11	Equipment organized for first pass without loss view	11 (100)	Yes
12	Selects and uses appropriate equipment	11 (100)	Yes
13	Suctions airway fluids safely	10 (90.9)	Yes
14	Grasps laryngoscope with left hand at junction of blade and handle	8 (72.7)	Yes
15	Laryngoscope tip in vallecula	5 (45.5)	No
16	Inserts laryngoscope to appropriate depth	10 (90.9)	Yes
17	Moves blade tip smoothly without shaking or jerking	4 (36.4)	No
18	Elevates mandible from 45°–90° with laryngoscope	6 (54.6)	No
19	Flips up epiglottis or exposes laryngeal inlet	10 (90.9)	Yes
20	Changes angle ETT toward feet when 2–3 in. in mouth	6 (54.6)	No
21	Maintains view until ETT has stopped advancing	9 (81.8)	Yes
22	Passes ETT with limited or no cord impingement	6 (54.6)	No
23	Passes tube through cords (laryngoscope in mouth to tracheal placement) in < 20 sec	8 (72.7)	Yes
24	Disconnects syringe *immediately* after inflating cuff of ETT	5 (45.5)	No
25	Confirms presence of breath sounds over each lung	11 (100)	Yes
26	Confirms absence of breath sounds on epigastric region	8 (80)	Yes
27	Checks end-tidal CO_2—after ETT placement	9 (81.8)	Yes
28	Checks pulse oximeter—after ETT placement	11 (100)	Yes
29	Secures ETT	10 (90.9)	Yes
30	Successfully intubates in one ETI attempt	6 (54.6)	No
31	Inserts oropharyngeal airway prior to BVM ventilation	8 (72.7)	Yes
32	Inserts oropharyngeal airway to proper depth	6 (60)	No
33	Chooses correct oropharyngeal airway size	9 (81.2)	Yes
34	Ventilates patient immediately (within 30 sec) with BVM	11 (100)	Yes
35	O_2 attached and flow > 12 L/min	11 (100)	Yes
36	Ventilates patient at rate of 10–12/min	8 (72.7)	Yes
37	Evaluates BVM technique for visible chest rise	11 (100)	Yes
38	Uses thenar eminence technique (E-C grip)	7 (63.6)	No
39	Preoxygenates prior to backup plan	11 (100)	Yes
40	Recognizes need for backup airway	11 (100)	Yes
41	Identifies an appropriate backup airway device	11 (100)	Yes
42	Backup airway appropriately used	11 (100)	Yes
43	Immediately inflates cuff, prior to ventilation	9 (81.8)	Yes
44	Immediately disconnects syringe after inflating cuff	6 (54.6)	No
45	Confirms proper backup placement by auscultation over each lung	11 (100)	Yes
46	Confirms absence of breath sounds on epigastric region	10 (90.9)	Yes
47	Checks end-tidal CO_2—after backup airway placement	9 (81.8)	Yes
48	Checks pulse oximeter—after backup airway placement	11 (100)	Yes

(Continued)

Table 1 (continued)

Item Number	Item Description	Frequency (%)	Critical for Patient Safety/Outcome
49	Maintains control over backup airway after placement	9 (90)	Yes
50	Successfully places backup airway within one attempt	8 (72.7)	Yes
51	Ventilates without interruption of > 30 sec at any time	11 (100)	Yes

Frequency (%) is the number and percentage of judges who deemed the item to be critical. Items achieving 70% or more of expert consensus were judged as critical.
BVM = bag-valve-mask; ETI = endotracheal intubation; ETT = endotracheal tube.

Table 2
Beginning and Mastery Performance Expectations for Comprehensive Airway Management

		Beginning Proficiency		Mastery Proficiency	
Item Number	Item Description	Item *Must Be Done* to Pass	Probability That Well-prepared Beginning Residents Will Accomplish This Task	Item *Must Be Done* to Pass	Probability That Mastery-level Residents Will Accomplish This Task
1	Positions patient optimally (trauma, ramp, sniffing)		69.1	Yes	100
2	Does not assess gag reflex		59.1	Yes	86.4
3	Assures continuous pulse oximeter	Yes	90.1	Yes	100
4	Identifies primary and backup plan		69.1	Yes	100
5	States correct dose induction agent (local standards)		65.5	Yes	100
6	States correct dose neuromuscular blockade (local standards)		63.2	Yes	100
7	Uses straight-to-cuff stylette curvature technique		50.5		77
8	Checks equipment for cuff leaks		69.1	Yes	89.1
9	Maintains C-spine precautions during airway management	Yes	90.9	Yes	100
10	Uses cricoid pressure	Yes	38.6		41.4
11	Equipment organized for first pass without loss view		67.3	Yes	100
12	Selects and uses appropriate equipment	Yes	80.9	Yes	100
13	Suctions airway fluids safely	Yes	91.4	Yes	98.2
14	Grasps laryngoscope with left hand at junction of blade and handle	Yes	85.5	Yes	90.9
15	Laryngoscope tip in vallecula		63	Yes	86
16	Inserts laryngoscope to appropriate depth	Yes	79.5	Yes	98.2
17	Moves blade tip smoothly without shaking or jerking		45.5	Yes	97.7
18	Elevates mandible from 45°–90° with laryngoscope		63.2	Yes	85
19	Flips up epiglottis or exposes laryngeal inlet	Yes	76.4	Yes	98.6
20	Changes angle ETT toward feet when 2–3 in. in mouth		52.3	Yes	71.8
21	Maintains view until ETT has stopped advancing		55.9	Yes	90.9
22	Passes ETT with limited or no cord impingement		49	Yes	90.9
23	Passes tube through cords (laryngoscope in mouth to tracheal placement) in < 20 sec		41.8	Yes	94.5
24	Disconnects syringe *immediately* after inflating cuff of ETT		64.1	Yes	96.4
25	Confirms presence of breath sounds over each lung	Yes	98.2	Yes	100
26	Confirms absence of breath sounds on epigastric region	Yes	91.5	Yes	90
27	Checks end-tidal CO_2—after ETT placement	Yes	87.3	Yes	100
28	Checks pulse oximeter—after ETT placement	Yes	96.4	Yes	100
29	Secures ETT	Yes	77	Yes	91.4
30	Successfully intubates in one ETI attempt	Yes	41.4	Yes	90.5
31	Inserts oropharyngeal airway prior to BVM ventilation		71.5	Yes	99.5

(Continued)

Table 2 (continued)

Item Number	Item Description	Beginning Proficiency		Mastery Proficiency	
		Item *Must Be Done* to Pass	Probability That Well-prepared Beginning Residents Will Accomplish This Task	Item *Must Be Done* to Pass	Probability That Mastery-level Residents Will Accomplish This Task
32	Inserts oropharyngeal airway to proper depth		70.5	Yes	97.5
33	Chooses correct oropharyngeal airway size	Yes	82.5	Yes	99.5
34	Ventilates patient immediately (within 30 sec) with BVM	Yes	95	Yes	100
35	O_2 attached and flow > 12 L/min	Yes	95	Yes	100
36	Ventilates patient at rate of 10–12/min		59.5	Yes	81
37	Evaluates BVM technique for visible chest rise	Yes	86.4	Yes	98.6
38	Uses thenar eminence technique (E-C grip)		67.3	Yes	93.2
39	Preoxygenates prior to backup plan	Yes	90.9	Yes	100
40	Recognizes need for backup airway		73.6	Yes	100
41	Identifies an appropriate backup airway device		71.8	Yes	100
42	Backup airway appropriately used		70.9	Yes	100
43	Immediately inflates cuff, prior to ventilation	Yes	82.3	Yes	99.5
44	Immediately disconnects syringe after inflating cuff		70.5	Yes	94.5
45	Confirms proper back up placement by auscultation over each lung	Yes	95.5	Yes	100
46	Confirms absence of breath sounds on epigastric region	Yes	88.6	Yes	90.9
47	Checks end-tidal CO_2—after backup airway placement	Yes	86.8	Yes	100
48	Checks pulse oximeter—after backup airway placement	Yes	95	Yes	100
49	Maintains control over backup airway after placement		69.5	Yes	90
50	Successfully places backup airway within one attempt		54.1	Yes	93.6
51	Ventilates without interruption of >30 sec at any time	Yes	74.5	Yes	99.5

evaluate mastery proficiency, the raw score and percent correct items were calculated. The cut score for mastery level performance was determined to be 48 of 51 (94%) of items performed correctly in the evaluation. Considering the patient-safety approach, experts noted that the 49 of 51 (96%) of the items identified in the scenario were essential for mastery-level comprehensive airway performance. Only two items were not determined to be critical based on the mastery-level assessment: these included using cricoid pressure and using straight-to-cuff stylette curvature technique.

DISCUSSION

A standard-setting procedure was conducted with residency education and airway management experts to define specific standards for EM trainees. Even with the fundamental challenges associated with airway management, there is a paucity of data on assessing airway performance behaviors, outside of success rates, during graduate medical education. Our study is the first to define airway performance standards for EM trainees.

Through these methods, experts identified the comprehensive airway management tasks that were critical for patient safety and outcome along with defining proficiency levels for beginner and mastery levels. Experts easily identified items which were critical for patient safety for any learner level if practicing independently (Table 1). This list differed from the beginning and mastery-level performance tasks defined by the panel. The beginning-level task list did not include all the critical patient-safety items (Table 2). Since beginning residents are directly supervised by attending physicians, the beginning list may serve as the minimal ability that a PGY-1 resident should possess prior to attempting supervised airway management in the clinical setting. In contrast, the mastery-level proficiency list included almost all performance tasks including those critical for patient safety and outcome (96%, Table 2). Therefore, the expert panel defined mastery-level performance as maintaining skills beyond the critical aspects of performance and including noncritical tasks, which may optimize success.

We discovered that the modified patient-safety standard setting better profiles the clinical airway

management practice for EM residents since they are actively supervised by board-certified EM physicians. This is apparent in the lower numbers of critical tasks required of novice trainees by the patient-safety method (49%) compared to the Angoff (73%). The patient-safety standard-setting method takes into account the difference in supervision of EM residents while the modified Angoff is based solely on the probability of a learner to accomplish each task. Interestingly, the results of the two standard-setting methods were similar for mastery since experts recognized the need for high performance as trainees transition to independent practice.

In the anesthesia literature, airway standards have been suggested to be from 27 to 57 ETI cases to reach a 90% success.[3,18,19] Currently, in EM, the Milestone Project provides good guidance for assessment of resident procedural competency.[20] At level 4, residents are required to complete a minimum of 35 intubations for competency. One recent evaluation examined the development of learning curves in EM residents by cumulative summation testing and defined 74.7 intubations as a number needed to achieve a 90% success rate for ETI.[21] The implication of this, however, is an accepted 10% failure rate that, when placed in the context of the significant morbidity and mortality of failed airway management, should not be tenable.

The milestones provide a strategic framework that educators can use to communicate progress throughout training. However, current assessment methods involving counts of the number of times a trainee completes a procedure do little to inform medical educators about the trainee's proficiency with regard to that procedure. The challenge now is to design rigorous performance assessments with defined standards to improve milestone designation. This exercise helped us to see that for airway management, even a resident who is designated as having passed the novice standards would not be qualified to perform airway management on a patient in distress. This finding will help educators to properly design training programs to effectively prepare, assess, and identify residents who have mastered safe and effective airway management skills. Using proper standards will lead to progressive improvement and better patient-safety outcomes. Novice trainees can be provided with deliberate practice in the simulation environment where their airway skills can be honed until they reach mastery level and are certified to perform airway management on a patient in need. Practice in the simulation environment with airway models of different levels of difficulty will enhance training and assessment.

LIMITATIONS

Our data concerning proficiency standards were derived from individuals who have been identified as experts in airway management or residency education. It is possible that another expert panel, depending on the composition, may select different items as critical for airway management or perceive a different proficiency standard for novice and mastery levels. However, we have tried to mitigate this through the specific choice of individuals who possess significant experience as identified by their involvement in the Airway Mastery Collaborative. Additionally, we used a large group of individuals such that all perspectives could be expressed.

Further, although these are standards set by experts for each proficiency level, it is unclear whether resident trainees attain these proficiency levels. Not all trainees at the start of a residency program possess the same baseline skills, and it is unknown how many require additional training prior to clinical practice. Further, it is unclear if residents, at graduation, attain mastery level of proficiency. Future work will focus on identifying these proficiency levels in current resident trainees utilizing this simulation scenario.

Finally, the items identified as critical for patient safety in this simulation scenario may not be the same for other scenarios. The standard setting was specifically directed at the defined scenario provided to the experts. Other scenarios may require standard setting to clearly define proficiency levels.

CONCLUSION

In this study, we established emergency medicine resident performance standards for comprehensive airway management during a simulation scenario. A panel of graduate medical education, airway management, and simulation experts defined performance expectations for novice and mastery level emergency medicine trainees. The patient-safety standard-setting method was found to best reflect the supervised practice of emergency medicine residents. Future work will focus on identifying these proficiency levels in current resident trainees utilizing this simulation scenario.

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APPENDIX A

Airway Mastery Collaborative (AMC) Study Group

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Supporting Information

The following supporting information is available in the online version of this paper available at http://onlinelibrary.wiley.com/doi/10.1002/aet2.10127/full

Data Supplement S1. Supplemental material.